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Medication Error Prevention Strategies

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Contents

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Executive Summary

The fundamental purpose of every healthcare organization is to enhance patient quality of life through the provision of superior healthcare to produce the best patient outcomes. In the pre-hospital practice setting of helicopter emergency medical service (HEMS) the desire of system leaders and medical staff is to be primarily patient-centered, focused on the safety and wellbeing of patients while at the same time managing the business finances and budget of the organization. Maintaining a healthy environment with safe patient practices is the responsibility of organization administrators, physicians, nurses, paramedics, and all healthcare providers.

One of the primary duties that healthcare providers perform while caring for their patients is the preparation and administration of medications. The significance of accurately preparing and administering medications is fully recognized by practicing nurses and paramedics, and a continual effort to maintain patient safety is, and always will, be central to the philosophy of healthcare professionals. However medication errors continue to be a serious problem threatening the well-being of patients and the success of healthcare systems with potentially increased length of stays, escalated healthcare costs, heightened risks to safety, diminished confidence levels in healthcare providers, and can potentially lead to such devastating consequences as patient harm or death. Information from the report *To Err is Human – Building a Safer Health System,* The Institute of Medicine (2000), indicates as many as 98,000 patients die each year as a result of medical errors. According to the National Coordinating Council for Medication Error Reporting and Prevention (NCC MERP), (2020) a medication error is any preventable error that may cause or lead to patient harm while the medication is in the control of the health care professional. These errors may be related to medication practices, procedures, and system processes such as prescribing, order communication, product labeling,

packaging and nomenclature, dispensing, administration, education, monitoring, and use. The common vision of this council is to prevent any harm to a patient due to a medication error, and their mission is to optimize the safety of medication practices and to raise awareness of medication errors by creating a just culture with open communication, increased self-reporting, and the promotion of medication error prevention strategies (NCC MERP, 2020). The aspiration of that very vision and mission is the aim of this benchmark project. The projected goal of this initiative will be the effective implementation of evidence-based strategies in the Air 1 program to reduce medication administration errors with improved healthcare provider awareness, knowledge levels, and behaviors surrounding medication preparation and administration.

Medication Error Prevention Strategies

One of the primary responsibilities of the healthcare professional providing patient care is the safe and accurate administration of medications. Despite this, medication errors continue to be a consistent and serious problem within healthcare organizations and are difficult to completely eliminate (Aldhafeeri & Alamatrouk, 2019). These preventable errors can have grave consequences on patient outcomes, increase healthcare system costs, and reduce confidence in healthcare professionals. In an effort to examine the effects of evidence-based prevention strategies and to potentially affect a positive change, the following PICOT question is posed: In Air 1 healthcare providers (P) how does the application of medication error prevention strategies (I) compared to no strategies (C) improve provider awareness, knowledge levels, and behaviors during medication preparation and administration (O) in a three month period (T)?

Rationale for the Project

The priority of maintaining a healthy environment with safe patient practices is the core responsibility of all healthcare professionals. Medication administration errors (MAEs) have the potential to significantly impact patient health and are directly associated with mortality and morbidity rates. MAEs are experienced by up to 14% of hospitalized patients, injure an estimated 1.5 million patients, and are fatal for approximately 7000 patients each year (Hammoudi & Abu Yahya, 2018). The financial impact of medication errors can be observed in escalated healthcare system costs of almost $4 billion annually from increased hospital length of stays and civil liabilities (Aldhafeeri & Alamatrouk, 2019). There are many pathways in which medication errors can take place and many factors that may attribute to their occurrence (Aldhafeeri & Alamatrouk, 2019). Medication errors occur from multi-dimensional failures through a complex interconnected process beginning with prescribers and ending with bedside

care providers as the last barrier to prevent medication error (Flynn, 2019). To visualize how errors occur in a system, the "Swiss Cheese Model of System Error" created by James Reason (2000), demonstrates multiple slices of Swiss cheese layered side by side as potential barriers to the occurrence of error, with bedside caregiver medication preparation and administration as the last piece in the drug process (Bessa et al., 2019). According to Di Simone et al. (2018), adequate knowledge, positive attitudes, professional behaviors, and fundamental training are vital factors to the reduction of medication errors.

Increasing educational requirements for healthcare providers can provide one avenue to aid in reducing MAEs, but further strategies can be implemented for the overall improvement of medication practices to reduce errors. According to the American Society of Health Systems Pharmacists [ASHP] (2017) safe medication practices begin with placing medication safety as an institutional and departmental priority. Principle elements of a successful strategy for safe medication practices include the utilization of a medication safety leader and a philosophy built on safety based on a just culture that is supported throughout the organization (ASHP, 2017). The development of improved protocols based on best evidence and practical recommendations from a multidisciplinary medication safety team can reduce medication errors within a healthcare system (ASHP, 2017).

The University of Texas Health-East Texas (UTH-ET) Air 1 program is a helicopter emergency medical service (HEMS) that operates to expedite critical care patient transfers within the East Texas area, and functions with a pilot, nurse, and paramedic on each patient flight. HEMS is a high-stress, high-speed healthcare environment. Air 1 performs patient transfers from smaller rural hospital systems to larger facilities with increased patient care capabilities. The flight program also responds to various accident scenes and medical emergencies. Air 1

caregivers provide patient care in exceptionally small spaces and are continually exposed to extremes in temperature, noise, vibration, wind turbulence, and poor lighting. In addition to these significant distractions, caring for patients is not their only duty. In areas with busy airspace, medical crews also need to be alert to unexpected or unannounced air traffic. This environment is ripe with the potential for MAEs.

The Air 1 program educator, Sam Behr and Physician Director, Dr. Yagnesh Desai collaborate together to form the existing Air 1 safety team. They have developed patient treatment protocols and regularly review charts for deviations or potential errors. Crew education and patient safety are viewed as the programs greatest priorities. Air 1 nurse and paramedic caregivers are required to maintain a combination of live and online continuing education hours (CEs) to preserve current licensure. The medical crews are also required to retain basic and advanced life support which provides education to staff on a regular basis regarding some emergency medication administration practices. In addition, all providers are directed to obtain specific advanced certifications in order to practice in the Air 1 setting. Mandatory online training is provided by the Informatics department through the Net Learning and Ninth Brain computer programs for annual competencies, and requires program healthcare staff to complete one or two different topics each month. All Air 1 employees must attend quarterly staff meetings in which information, call reviews, and follow-up education is provided. Annual simulation education training is mandatory through skills training to continually reinforce policies and maintain clinical proficiencies in bedside patient care.

Project Goals

Despite the high standards of continuing education in the Air 1 program some errors continue to occur. In HEMS there are few stop-check safety measures in place for medication administration. There is only one patient on each flight so the need for patient identification verification is unnecessary. However, multiple medications with small labels and even smaller writing are stored together in bags with no rhyme or reason as far as their indications for use. This is a standard in HEMS to allow for compact storage and easy access in flight. Medication errors in this setting are primarily related to caregiver medication choice for treatment, product labeling, rate of administration, and medication drip preparation, The goals of this benchmark change project are to increase Air 1 staff awareness of the occurrence of medication errors, improve staff knowledge levels with increased medication specific education, and to improve staff behaviors related to medication administration through the adoption of the following 8 recommended steps for safe medication administration.

Literature Synthesis

There is a distinct message observed throughout the literature that preventable MAEs are a common and serious problem facing healthcare organizations today. Organizational strategies developed to prevent MAEs vary depending on what is observed as the root cause of the problem; therefore it is first necessary to determine the causes of MAEs and with that information progress to the implementation of effective evidence-based error reduction strategies to improve patient safety. Evidence reveals that the primary contributors to MAEs are prescription and transcription errors; a lack of knowledge related to inadequate education and training; dysfunctional organizational processes; and ineffective behaviors surrounding medication preparation and administration.

Numerous studies have examined the perceptions of nurses regarding possible contributing factors to medication preparation and administration errors. A cross-sectional descriptive study by Gorgich et al., (2016) performed in hospitals and nursing schools in Zahedan, examined the causes of MAEs from the perspectives of nurses and nursing students in order to utilize the information for the development of effective error prevention strategies. According to nurses' viewpoints, the implementation of electronic medication cards and pharmacology educational workshops would improve access to necessary information and increase knowledge levels to effectively achieve a reduction of MAEs (Gorgich et al., 2016). A similar mixed method study by Escrivá Gracia et al., (2019) aimed to identify the primary MAEs that occurred in the ICU at a general hospital in Spain, and analyze the causes of the errors based on the perceptions of healthcare professionals to determine if a lack of pharmacology knowledge contributed to the errors. The professionals identified four major areas that led to increased MAEs consisting of practice environment, organization of the unit, personal factors, and the medication administration process. According to Escrivá Gracia et al., (2019) the most frequent and dangerous errors are the incorrect interpretation of orders because they often go undetected until it is too late. This study also found that nurses generally had low levels of pharmacology knowledge related to the medications they were administering (Escrivá Gracia et al., 2019). It was determined that effective prevention must begin with a focus on the system so that it may be redesigned to be stronger and more error-proof (Escrivá Gracia et al., 2019). A mixed methods study by Alomari et al., (2018) outlined the current workplace culture of medication practices in a pediatric unit, and examined nursing perceptions on the causes of medication errors. This study identified four primary themes: (1) understanding medication errors, (2) the busy-ness of nurses, (3) the physical environment, and (4) compliance with medication policy and practice

guidelines (Alomari et al., 2018). This study concluded that according to nursing perceptions, high workload, interruptions, poor physical environment, and impractical policies contributed to medication errors. Di Simone et al.,(2018) aimed to define which aspects of nurse's knowledge, training needs, behaviors, and attitudes could potentially prevent medication errors in the emergency room. An anonymous questionnaire was developed and supplied to 103 emergency room nurses in a university hospital in Rome. Only 15.6% of nurses felt their knowledge was adequate related to the preparation and administration of intravenous (IV) medications (Di Simone et al., 2018). The conclusion of this study exhibited the unquestionable necessity for regular continuing education and improved knowledge levels for nurses administering IV medications (Di Simone et al., 2018).

The effectiveness of specific interventions for the reduction of MAEs were investigated by several studies. The aim of the systematic review by Bessa Mieiro et al., (2019) was to improve patient safety through the assessment of error reduction strategies used by nursing teams within emergency units. Three national studies were analyzed, a prospective, transversal, and an exploratory survey examined the variables of positive deviation, instrumentalization, education, and elaborated protocols with the participation of a multidisciplinary team. It was determined that to minimize medication errors, the multidisciplinary team is required to provide a safe working environments with effective communication skills among health professionals to execute strategies to eradicate the medication error chain with educational and organizational strategies and new technology (Bessa Mieiro et al., 2019). A quality improvement process by Conner et al., (2016) implemented a distraction-free practice with the "Red Zone Medication Safety Initiative" in a large urban inpatient cardiovascular program in a free-standing quaternary care children's hospital. This initiative resulted in a significant reduction in medication errors of

79% or better (Conner et al., 2016). The study concluded that the implementation of a distraction-free practice was feasible and effective and could be equally effective if expanded to other units within the hospital (Conner et al., 2016).

Evidence shows that education and training play a significant role in the reduction of MAEs among healthcare workers. A randomized controlled trial performed by Johnson et al., (2019) in eight hospital wards in Australia examined the feasibility of a behavioral e-learning intervention to support nurses in the management of interruptions during medication administration in order to reduce MAEs. This behavioral intervention was not found to significantly reduce interruptions; however it did result in improved error prevention strategies practiced among staff. A systematic review by Sarfati et al., (2019) examined 21 studies to assess the effectiveness of human-simulation-based training in the prevention of MAEs by improving knowledge, skills, and attitudes of nurses and other healthcare staff. This review concluded that properly regulated simulation training was an effective way to train staff for rare events in addition to standard activities (Sarfati et al., 2019). According to Sarfati et al. (2019), the integration of human factors through simulation training was effective in prevention of iatrogenic risk related to MAEs.

New and innovative approaches to reducing MAEs have examined the human component contributing to medication errors. A multifaceted pilot program conducted by Durham et al., (2016) explored these human factors. This study aimed to reduce medication administration errors in acute and critical care settings by examining nursing awareness and behaviors. An interprofessional team developed a human factors-based medication safety pilot program to intercept potential medication errors. Positive results were achieved and medication errors were reduced with increased situational awareness accomplished by the utilization of a strategy of

mindfulness (Durham et al., 2016). Another study that examined the human element of medication errors was the quality improvement initiative by Ragau et al., (2018). This investigation explored the Hungry, Angry, Lonely, and Tired (HALT) model to reduce MAEs in one 32-bed medical ward in Australia. An event that occurred in this hospital led to their perceptions that human factors are often overlooked as being significant contributors to MAEs. In this initiative, the use of the HALT method resulted in a reduction of MAEs by 30% (Ragau et al., 2018).

Advancements in technology have significantly impacted medication error rates and contributed to improved patient care. In a retrospective descriptive study by Vaidotas et al., (2019), medication errors were compared in emergency departments with electronic medical records to departments that utilized conventional handwritten records within the same organization. In this study there were twice as many error events that occurred in departments with conventional medical records compared to electronic medical records in 9 of 14 categories (Vaidotas et al., 2019).

Plutinska and Plevova (2019), reviewed studies on the effectiveness of measures to prevent medication errors in intensive care units (ICUs). Interventions such as pharmacist involvement, automated infusion devices, reporting of medication errors, limiting interruptions, electronic health records, education, and checklists were assessed. Their conclusion suggested that to an extent, all of these error prevention strategies showed some medication error reduction (Plutinska & Plevova, 2019).

Project Stakeholders

The UTH-ET organization's executives, Air 1 administrators, physicians, educator, and in particular healthcare bedside providers, are the primary stakeholders identified and impacted by this proposed benchmark project for improved caregiver awareness, knowledge levels, and behaviors for reduced medication administration errors MAEs. The inclusion of multidisciplinary teams will facilitate the effective implementation of evidence-based error prevention strategies. Key stakeholders will be engaged through an interdisciplinary teamwork approach to identify and approve effective educational content and strategies concerning this change (Rodgers et al., 2019). The Nursing Director of Air 1, the program educator, and Air 1 Physician Director will be effective allies who will assist in this change project in order to reduce MAEs within the Air 1 program and improve patient safety. Patients and their families are also important downstream stakeholders for the improved safety of medication administration practices. If patients and family members are not included as valuable members of their own healthcare team they may not understand the importance of improved strategies to prevent MAEs, and may not adhere to the forthcoming advanced requirements of standards of patient practices and care.

Implementation Plan

The anticipated site in which this benchmark change project will take place is within the Air 1 program at the University of Texas Health System-East Texas. The first essential element of the successful implementation of change must be the creation of a common vision. The current shared vision of this organization is that of being a health partner for life with the mission and purpose of caring for patients, their families, and each other while educating and developing caregivers of the future. In order to affect a positive change, and to effectively change behaviors

contributing to MAEs in the Air 1 program, this benchmark change project will aim to provide in-person and online education modules, 8-step practice guidelines for safe medication practices, training through simulation experiences, easily accessible resources regarding medication references and protocols, and effective tools in the form of programmable medical equipment.

Detailed Plan Steps with Timetable/Flowchart:

Pre-Implementation Information Gathering

- Establish the existence and prevalence of MAEs that occur in the Air 1 program by collecting and analyzing internal data on documented medication errors through departmental quality improvement (QI) data. Ascertain levels of undocumented errors with face to face interviews with Air 1 crew members.
- Evaluate current Air 1 practices, and identify weaknesses that may contribute to MAEs.
- Develop PICOT question: In Air 1 healthcare providers (P) how does the application of medication error prevention strategies (I) compared to no strategies (C) improve provider awareness, knowledge levels, and behaviors during medication preparation and administration (O) in a three month period (T)?

Step 1 – Propose the Change

- Gain approval from leadership stakeholders to implement change project. Explain the positive implications of promoting this change in the Air 1 program. Propose the following changes project to leadership stakeholders 1 month prior to first flight meeting:

1. Increase Air 1 staff meetings from quarterly to monthly. Review indications, dosage, side effects and contraindications of 2-3 different medications in each flight meeting. Require staff to attend 10 out of the 12 meetings. Integrate meeting attendance into yearly evaluations.
2. Following each meeting provide online educational material through Net Learning or Ninth Brain relating to reviewed medications. Staff will have two weeks to complete module, post-test passing score of 90% required.
3. Provide mandatory annual simulation lab training incorporating real life scenarios with normal teams of two crewmembers. Combine medication practices in experience.
4. Update and provide easily accessible program protocols annually. Maintain full libraries of medications in IV pumps.
5. Pilot a policy of following the 8 recommended steps for safe medication practices.

- Generate a sense of urgency. Increase stakeholder awareness of occurrence of MAEs and their potential harm.
- Create a common vision and generate buy-in among stakeholders for improved patient care through increased provider awareness, knowledge levels, and behaviors during medication preparation and administration.

Step 2 – First Flight Meeting: Share the Plan (Week 1)

- Present medication error information and rationale for change to Air 1 employees. Engage staff by raising awareness of MAEs.

- Share implementation plan and provide staff with new expectations regarding flight meeting attendance and educational modules.
- Collect pre-implementation Air 1 crew responses to 8-step audit tool of safe medication practices to establish baseline. Incorporate tool into post-flight QI form.

Step 3 - Establish Interdisciplinary Committee (Week 1)

- Establish a formal interprofessional committee including Air 1 administrators, educators, and caregivers. Build excitement for improved patient safety and care among stakeholders. Compliment and encourage efforts to improve patient care through better medication practices.
- Schedule weekly team meetings and provide action plans with set goals to collect, critically appraise, evaluate, and synthesize external best evidence-based practice (EBP) for effective strategies to reduce MAEs. Begin reviewing protocols.

Step 4 - Implementation Planning (Week 2)

- Formulate practice and educational recommendations based on synthesized evidence. Devise new standards of Air 1 medication administration practices. Increase knowledge through online education modules and improve behaviors through 8 step medication safety measures.
- Achieve stakeholder support and assess and eliminate potential barriers by building confidence in change project for improving patient safety and care and reducing system costs by reducing errors and potential litigation.
- Develop clinical and educational tools for project implementation. Construct new protocols and integrate into informatics programs for online resource and training

modules, ensure all IV pumps are programmable and contain a comprehensive library of medications, and obtain necessary training equipment and permission for use of simulation labs.

- Schedule education/simulation training for all Air 1 crew members with required recurrent training annually.
- Dr. Desai will gather information on 2-3 medications to discuss in second flight meeting. Implementation team will develop follow-up online educational material for staff with post-test.

Step 5 – Second Flight Meeting: Begin Medication Education (Week 4)

- Disseminate first educational lectures on selected medications to staff. Allow for open discussions. Build excitement and make the change and educational experiences positive and fun!
- Provide staff encouragement for the vision of increased caregiver awareness, improved knowledge, and better patient care through strategies to reduce MAEs
- Make follow-up online educational material available to staff.

Step 6 – Third Flight Meeting: Disseminate Protocols (Week 8)

- Implementation team will have completed reviews on program protocols and will disseminate to staff through easily accessible application on electronic devises including phones, laptops, and base computers with assistance from IT department.

Step 7 - Simulation Lab Training (Week 8)

- Team will have secured dates for annual simulation lab training and develop scenarios incorporating medication practices with reviewed medications. Scenarios will be observed and WCCAT (McCormack et al., 2009) and audit tools will be utilized.

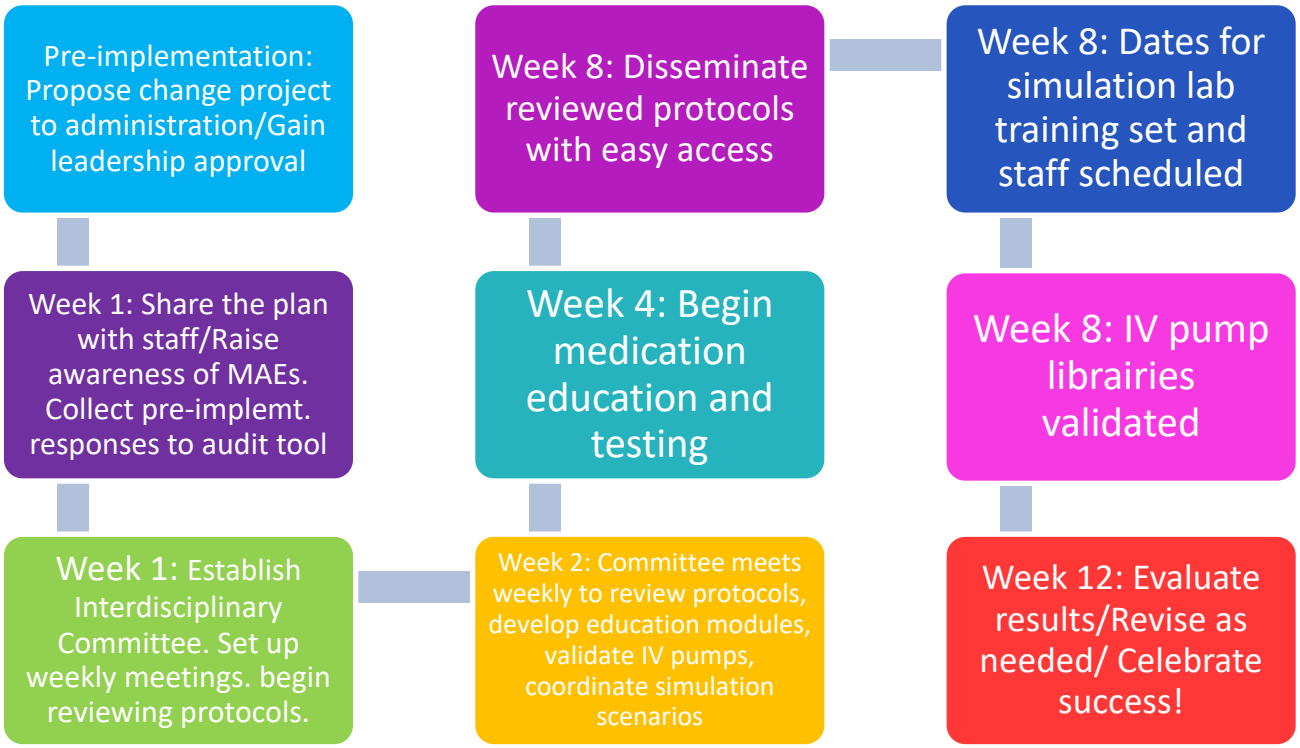
Step 8 - IV Pumps (Week 8)

- Implementation team will have examined all program IV pumps to insure they contain a full library of utilized medications.

Step 9 - Celebrate Success! Evaluate results and Re-evaluate Progress (Week 12)

- Acknowledge fellow project team members for their contributions to the project. Celebrate the success of you and your team in the EBP process!
- Analyze data on outcomes and refine change practices as necessary. Evaluate effectiveness of change project at 3 months, 6 months, and 12 months with post-flight QI forms, monthly online education, simulation lab results with WCCAT (McCormack et al., 2009) , and staff feedback.
- Integrate training as role expectation and imbed in job requirement and inform new employees of expectation in orientation.

Flowchart



Data Collection Methods

Initial data collection for this benchmark study will be accomplished by assembling and analyzing internal data on documented medication errors through Air 1 departmental computerized quality improvement (QI) data and through Trideo, the Integrated Risk Information Management System (RMIS). In-person interviews with Air 1 patient care providers will provide potential information on undocumented errors. Pre-implementation data will also be collected with completed 8-step audit forms. This information will provide a baseline to measure results. Post-implementation data will be collected at 3, 6, and 12 months,

and 2 years with information gathered from QI, Trideo events, WCCAT observations for simulation labs, and post-implementation 8-step audit forms.

The outcomes of this project will be measured by improved Air 1 caregiver awareness of the potential for MAEs. This awareness will be attained through the attendance of all caregiver staff to 10 out of 12 flight meetings each year. Mindfulness of the potential for error will be achieved through information sharing in the initial flight meeting and will be emphasized with the continuing medication education provided. In post-implementation data collected at 3, 6, and 12 months Trideo events will optimistically be reduced by 50-100%. Compliance of 100% will be expected in each post-flight QI form with the integrated 8-step medication safety tool. If complete compliance was unable to occur, the QI form will automatically generate a justification form to be completed and this will be sent to Dr. Desai to review. Through the utilization of the WCCAT tool, observations of simulation lab training scenarios will improve consciousness and draw out problems that need to be resolved through increased and focused education and additional training. The success of this program will be measured by the participation of all Air 1 healthcare providers playing their part to improve their own awareness, knowledge levels, and behaviors related to medication preparation and administration.

Cost/Benefit Discussion

Providing increased education and training to employees can be costly for an organization. The benefits for that expense, however, can pay off in great dividends for years to come. Increased hospital length of stays for patients and the growing propensity towards civil litigation can amount to billions of dollars in organizational expenditures each year. The total costs for this change project is estimated to be $23,754. That figure is entirely comprised of employee wages paid to attend meetings and training ($19,398 + $4356). Air 1 crew members

work two 24 hour shifts per week at three stations that are off of the main hospital site, and therefore cannot attend training on the days they are working. Due to the experience and certifications required to be employed as a crew member, Air 1 employees are also very tenured in their positions with the average employee having 20 plus years of experience causing wages to be higher than average. Online educational modules are factored into each employee yearly education budgets and will not be an additional charge in this project. Dr. Desai's salary is paid partially by the Air 1 program. He is the physician director of Air 1 and maintains medical control over the policies and protocols. The services he provides related to training and education are already paid for as part of his salary.

Although the cost of this change project appears steep at first glance, it is far outweighed by the benefits in many ways. Reduced healthcare provider medication errors will result in fewer liabilities, decreased patient hospital stays, improved patient health, satisfaction, and confidence in healthcare providers. Healthcare is a business. Patient word of mouth on personal satisfaction, confidence levels, and experiences can influence choices in healthcare systems. At the forefront of the benefits of this project however is the increased safety of patient care and improved patient outcomes.

Discussion of Results

It is anticipated that organizational executives, Air 1 administrators, physician, educator, and staff crew members will be receptive to this future change project. Awareness of medication errors will likely be increased among administrators and staff with information presented by Dr. Desai. Increasing flight meetings from quarterly to monthly with educational lectures on medications and follow-up online modules will improve knowledge levels among Air 1 patient

care providers. It is anticipated that simulation lab training and post-flight audit tool will improve caregiver behaviors surrounding medication preparation and administration.

This change initiative was developed as a benchmark project due to the COVID-19 pandemic that has overwhelmed hospitals, staff, and emergency care workers over the past year. The project was not presented to Air 1 leadership at this time because of the severity of staffing shortages requiring all employees to work extra shifts including Air 1 administrators. The COVID-19 crisis has escalated across the country and is especially being felt in the East Texas area with shortages even in necessary emergency care services. However, once the crisis has been stabilized and some normalcy has returned to healthcare this project will be implemented if approved. Through improved provider awareness, knowledge levels, and behaviors during medication preparation and administration MAEs will continue to decrease.

Conclusions/Recommendations

The ultimate responsibility of the healthcare provider is the safe and effective treatment of patients. The administration of medications is a primary responsibility of healthcare providers and can greatly improve patient care and outcomes. There is also great potential for patient harm if medication errors occur. With the use of best evidence related to medication practices, caregivers can accomplish better patient care and reduce medication errors effective error reduction strategies developed through evidence-based practice. This change project should be considered as a potentially effective approach to the problem of MAEs within Air 1. Through an increased awareness of MAEs, improved medication knowledge, and better medication practice behaviors, medication administration errors can be reduced. The next step recommended in this project would be that a similar change initiative be enacted for emergency medical services (EMS).

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Appendix A

Evaluation Table

PICOT Question: In nursing healthcare providers (P) how does the application of medication error prevention strategies (I) compared to no application of strategies (C) improve nurse's awareness, knowledge levels, and behaviors during medication preparation and administration (O) in a three month period (T)?
PICOT Question Type (Make BOLD)**: Intervention** Etiology Diagnosis or Diagnostic Test Prognosis/Prediction Meaning

Caveats

1) The **only studies** you should put in these tables are the ones that **you know answer your question** after you have done rapid critical appraisal (i.e., the keeper studies)
2) Include APA reference
3) Use abbreviations & create **a legend** for readers & yourself
4) Keep your descriptions brief – there should be **NO complete sentences**
5) This evaluation is for the purpose of knowing your studies to synthesize.

Place your APA Reference here (Use correct APA reference format including the hanging indentation):

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Citation: (i.e., author(s), date of publication, & title)	**Conceptual Framework**	**Design/ Method**	**Sample/ Setting**	**Major Variables Studied and Their Definitions**	**Measurement of Major Variables**	**Data Analysis**	**Study Findings**	**Strength of the Evidence (i.e., level of evidence + quality [study strengths and weaknesses])**
Author, Year, Title	**Theoretical basis for study Qualitative Tradition**		**Number, Characteristics, Attrition rate & why?**	**Independent variables (e.g., IV1 = IV2 =)** **Dependent variables (e.g., DV =)**	**What scales were used to measure the outcome variables (e.g., name of scale, author, reliability info [e.g., Cronbach alphas])**	**What stats were used to answer the clinical question (i.e., all stats do not need to be put into the table)**	**Statistical findings or qualitative findings (i.e., for every statistical test you have in the data analysis column, you should have a finding)**	• **Strengths and limitations of the study** • **Risk or harm if study intervention or findings implemented** • **Feasibility of use in your practice** • **Remember: level of evidence (See Melnyk & Finout-Overholt, pp. 32-33) + quality of evidence = strength of evidence & confidence to act** • **Use the USPSTF grading schema http://www.ahrq.gov/clinic/3rduspstf/ratings.htm**

Vaidotas M., Yokota P. K. O., Negrini N.M.M., Leiderman D. B. D., Souza V. P., Santos O. F. P., & Wolosker, N. (2019). Medication errors in emergency departments: Is electronic medical record an effective barrier?	The EMR acts in preventing failures, with a potential for checking the entire process, from input of an item on prescription to it's administration.	Quantitative, retrospective, descriptive study	Setting: Physically independent EDs in different regions of city of Sao Paulo, under similar management All cases of ME reported in 1 year period. Number: 4 Eds-2 units used EMRs (Labeled 1 & 2) 2 units used conventional handwritten records (CHR) (Labeled 3 & 4). Characteristics: All cases reported by electronic recording of events. Similar population between EDs. Attrition rate: None. Retrospective	IV: Use of EMR Use of conventional paper charting NCC MERP classification Diagnosis Workload DV: Reduced MAEs	Compared the number of ME per million opportunities reported between the 2 groups. Classification done by NCC MERP Rate calculated based on ratio between number of reported ME by total number of pts eligible in each organization multiplied by 1 million so measurement in DPMO.	Absolute frequencies, ratios, and percentages Mann-Whitney test	Types of MEs and diagnoses (Back pain, respiratory illnesses, earaches, etc..) Larger number of MEs in units using CHRs compared to EMRs. Monthly rate of MEs during period studied. CHRs type of med, dose, and admin to allergic pts most frequent ME. EMRs most common MEs were prep/handling, wrong pt, wrong route, and wrong admin technique.	Strengths: Limitations: No limitations addressed Risk of harm: No Feasibility: No this comparison of CHRs to EMRs can show us the advantages of the EMR over the CHR but it is not necessary to repeat this study today. LOE: 6 USPSTF grade: B Level of certainty: Moderate

Plutínská, Z., & Plevová, I. (2019). Measures to prevent medication errors in intensive care units.	Are there evidence-based recommendations or expert recommendations for preventing MEs in ICUs related to nursing intervention?	Quantitative, descriptive review	Setting: SCOPUS and EBSCO electronic databases searched. Years 2008-2018 included except theoretical reviews. Studies gradually excluded using PRISMA recommendations. Number: Search yielded 189 records. 11 studies were key for review. *n*= 11. Characteristics: Studies focused on preventative strategies and measures to reduce risks assoc with drug admin in ICUs	IV: PI, AID, CPOE, CWS, IS, ME, MR, PG, SSCD, MEMS, QI Project, BCMA, educational strategies, mindfulness, "Red Zones", Interruption limitation, Increased knowledge, technologies. DV: Reduced MAEs in ICUs	Literature review	SCOPUS and EBSCO	PRISMA	Strengths: Numerous interventions assessed. Limitations: Availability of full texts. English as only language Search for studies in ICUs only Risk of harm: No risk of harm Feasibility: Yes using this study can provide multiple effective measures to prevent MEs but it does not suggest one over the other, rather combinations of methods. LOE: 5 USPSTF grade: B Level of certainty: Moderate

			Full text articles. Search words using PICOT format(Prevention, med errors, ICU). Attrition rate: None, chart review					
Durham, M. L., Suhayda, R., Normand, P., Jankiewicz, A., & Fogg, L. (2016). Reducing medication administration errors in acute and critical care: Multifaceted pilot program targeting RN awareness and behaviors.	Increasing RN sensitivity to the risk of potential MAEs, increasing compliance to recommended behaviors, will result in reduced MAEs	Quantitative, observational time-series study	Setting: Large urban med center. 35-bed acute care unit and 28 bed neuro ICU unit. Number: *n*=138 observations, 527 doses(231 baseline, 341 post program). 99 RNs trained (75% acute care, 79% ICU). Characteristics: IPI team met to identify problems. RNs polled on nonpilot units to identify contributing	IV: Multifaceted program on risks of MAEs DV: Improved RN awareness of potential risks of MAEs Improved behaviors surrounding med prep and admin process Reduced MAEs	Direct observations of med prep and admin.(60 before and 26 monthly over 3 consecutive months totaling 78 post pilot implementations) 10 week post program evaluation.	Risk ratio analysis Logistic regression Wald Chi-square Odds-ration	Program effect highest on day 1 61% and 73% improvement. Risk of error lower on days 2 and 3 before program and dropped 29% after program. Coefficient on number of meds variable has β of 1.232 Wald equal to 22.416 Sig level 0.00 0.466 99% of RNs agreed awareness of potential error risk increased, with intentions to change practice. After program error interception increased and mindfulness strategies improved situational awareness.	Strengths: Behaviors of RNs studied surrounding med prep and admin ca increase awareness Limitations: Small pilot study No comparison group Conducted in 1 organization Observations may have effect on observed. Subset of sample cared for pt 1,2,or 3 days in a row. Risk of harm: No risk of harm Feasibility: Yes this study can potentially reduce med errors by targeting RN awareness and behaviors related to med prep and admin. LOE:6 USPSTF grade: B Level of certainty: Moderate

			factors to MAEs. Attrition rate: None, observational study.				Process behaviors performed more consistently.	
Di Simone, E., Giannetta, N., Auddino, F., Cicotto, A., Grilli, D., & Di Muzio, M. (2018). Medication errors in the emergency department: Knowledge, attitude, behavior, and training needs of nurses.	Which elements of nurses' knowledge, training needs, behaviors, and attitudes can prevent MEs in the ED during al steps of the admin of IV meds?	Qualitative, descriptive study	Setting: ED of Policlinics Umberto 1 of Rome. Between April-June 2016. ED nurses. Number: *n=103* nurses Characteristics: 29%men 71%women Attrition rate: None, Questionnaire.	IV: Knowledge levels of ED RNs Raining needs of ED RNs Behaviors and attitudes of ED RNs surrounding administration of IV meds. Med error prevention strategies DV: Prevention/reduction of MAEs	Questionnaire tool 43 items and 7 sections Cronbach's alpha *r*=0.776	Chi square Student's *t*-test and Mann-Whiney test	94% answered that topics to med prep and admin of IV meds covered during basic course. 63% stated covered only during post basic course. 15.6% judged excellent their level of knowledge of IV med prep and admin. 89.3% thought they needed improvement 85.6% desired increased education during degree course attended. 30.3% agreed that postgraduate courses on use of IV drugs should be designed. Only 22% believed coaching of new recruit nurses critical to prevent MAEs.	Strengths: Study points out aspects for further study and discussion. Limitations: No statistical significance in sample size. Descriptive analysis restricted possibility to compare obtained data with sample features. Current survey performed in unique western hospital constituting limitation of phenomenon comprehension. Not possible in this study to demonstrate applicability of survey to other drug monitoring systems. Risk of harm: No risk of harm Feasibility: Yes it is feasible to perform this survey to determine nurses' knowledge, attitude, behavior, and training needs to reduce MAEs more effectively. LOE: 6 USPSTF grade: B Level of certainty: Moderate

Connor, J. A., Ahern, J. P., Cuccovia, B., Porter, C. L., Arnold, A., Dionne, R. E., & Hickey, P. A. (2016). Implementing a distraction-free practice with the Red Zone Medication Safety Initiative.	No theory stated	Qualitative, descriptive study.	Setting: Large inpatient cardiovascular program in urban , free standing, quaternary care children's hospital. 31-bed CICU unit, and 40-bed acute care cardiac unit. Number: Nurses from 2 CICU units. Total # med events for CICU =124. Total # med events for acute care cardiac unit =89 Characteristics: Study period baseline assessment done Jan 2009 for CICU unit. Study period baseline	IV: Implementation of Red Zone Medication Safety Initiative DV: Improved nurse's awareness, knowledge, and behaviors during medication preparation and administration. Reduced MAEs.	Medication event defined. Evaluation of events included overall number of reported events for each unit and calculation of unit's event rate at baseline with continued trending as rolling rate. Each event categorized by terms of cause, severity, outcome, level of preventability, and phase of occurrence. Event reaching patient Organization's Safety Event Reporting System used as data source.	Six Sigma Ratios Change acceleration process Percentages	Used to eliminate defects and reduce variation CICU med event rate 0.97 per 1000 doses administered Jan 2009. Dec 2014 0.20 per 1000 doses administered 79.2 % reduction in errors in CICU (p=0.00184) And 65.3% (p= 0.035) 2009 Top 3 med events reported were wrong dose, wrong med/fluid, med omitted, accounting for 65% of events. 2014 40% reduction of top 3 med events.	Strengths: Reduced med events and increased awareness of potential med errors. Limitations: Single hospital-based experience may not generalize to other health institutions. Use of Safety Event Reporting System database is self-report tool which may underestimate events. Introduction of barcode scanning process done at similar time period and may have contributed to reduced errors. Risk of harm: No risk of harm. Feasibility: Yes this is feasible in practice. The Red Zone Medication Safety initiative can enhance med safety and reduce med events. LOE: 6 USPSTF grade: B Level of certainty: Moderate

			assessment done Jan 2010 for acute care cardiac unit. Attrition rate: None. Observational					
Alomari, A., Wilson, V., Solman, A., Bajorek, B., & Tinsley, P. (2018). Pediatric nurses' perceptions of medication safety and medication error: A mixed methods study.	No theory or hypothesis stated	Mixed methods, descriptive and thematic study.	Setting: Data collected Feb 2014-July 2014. 17-bed complex pediatric ward in large pediatric teaching hospital. Direct observations during med prep and admin collected 3 consecutive weeks 250 bed teaching hospital Number: *n*=33 RNs Characteristics: Case mix	IV: Pediatric RNs perceptions of med safety and error. Organizational/environmental factors. Policies and guidelines. Facilitators and barriers of safety. DV: Medication safety and reduced MAEs.	Identify common themes and patterns: Adherence, errors, and trends. Simple descriptive statistics: Deviations in practice & non-compliance with policies. Thematic analysis	Thematic analysis Chi-square Coding	Study highlighted that numerous factors contribute to creating an environment that is not conducive to safe medication admin practice. Barriers to safe medication practice are numerous and interrelated consisting of workload, frequent interruptions to process, poor physical environment design, lack of preparation space, and impractical medication policies	Strengths: Hawthorne effect disappeared after a few days. Environmental context of information and multiple data collection methods. Limitations: Direct observational method can have effect on person observed introducing study bias and social desirability. Study conducted in only 1 pediatric ward which could influence transferability. Risk of harm: No risk of harm Feasibility: Yes this is feasible in practice. It is important to engage nurses to ensure their perspectives are heard so they can effectively collaborate with administrators to develop safe medication practices. LOE: 6 USPSTF grade: B Level of certainty: Moderate

			of children with varying med problems. Observations in ward 3-5 days a week to collect data. Attrition rate: None, observational study					
Gorgich, E. A., Barfroshan, S., Ghoreishi, G., & Yaghoobi, M. (2016). Investigating the causes of medication errors and strategies to prevention of them from nurses and nursing student viewpoint.	No theory or hypothesis stated.	Qualitative, Descriptive study	*n*=327 BSN nurses *n*=62 nursing students. Total *n*=389 Male-129 Female-198 Nurses from different wards (Surg, ER, GYN,ICU, Pedi) on fixed shifts of 3 specialty hospitals in Zahedan. Nursing students from midwifery school of ZUMS.	IV--Investigation of the causes of medication errors and error prevention strategies. DV--Reduction of ME's in all phases. -Identification of factors related to occurrence of ME's.	Questionnaire for data collection with reliability verified by test-re-test method for correlation. Validity approved. Sig level of 0.05 was adopted.	Mean, rate, standard deviation, frequencies Independent t-tests ANOVA Chi-square	Most common causes of ME's in nursing were tiredness due to heavy workload-97.8% And in Nursing students were drug calculations-77.4% According to Indep t-test no sig relationship between gender and ME's in nurses (p=0.08) ANOVA- There was sig relationship between working shift (p=0.012), Type of employment (p=0.003), and Type of ward (p=0.019) With mean of ME's. RN's POV:	Strength of Evidence (LOE)-VI Strengths: -Study conducted by examining most common causes of errors and necessary prevention strategies from viewpoints of nurses/nursing students who are directly involved in problem. -Their perspectives on difficulties and perceived pressures directly relate to problem and can assist in developing effective solutions. Weaknesses: -Study focuses on perspectives of individuals which are subjective. No risk of harm if implemented. Feasible in practice. USPSTF grade-B Level of Certainty- Moderate

			At least 1 yr. work experience in current ward. Working RN's have BSN degree Nursing students required to pass Pharm				Highest rate of ME's in RN's with rotary shifts in projective RN's and internal ward RN's. Students POV: Wrong drug calc, lack of pharm knowledge, and MD unreadable orders. According to independent t-tests there was a sig relationship between gender and ME's among students (p=0.63). ANOVA test showed sig relationship between ward and occurrence of ME's among students (p=0.03). RN's POV:Reducing RN/Pt ratio would reduce ME's Students POV: Create med calc practice and education.	
Escrivá Gracia, J., Brage Serrano, R. & Fernández Garrido, J. Medication errors and drug knowledge gaps among critical-care nurses: A mixed multi-method study	No theory or hypothesis stated.	Mixed method study. Qualitative and quantitative	Phase 1 *n*=87 hosp episodes. Simple random sample (Accuracy 10%) from tot admits over 1 year. CI-95%	IV--Investigation of causes of medication errors for the appropriate application of error prevention strategies. DV--Reduced incidence of ME's. -Identification of factors contributing to ME's.	National Coordinating Council for Medication Error Reporting and Prevention taxonomy. Phenomenological method Cronbach's alpha SPSS (v22) software used to analyze data.	Spearman's linear correlation coefficient analysis. Kruskal-Wallis test Mann-Whitney U test	Of 87 episodes in ICU, 51.7 male. Average age-57.7±16.13 yrs. Average LOS-5.97±7.41 days. 63.22% admitted post-op. 36.78% non-surg. 23.5% drug dose units considered high risk.	Strength of Evidence (LOE)-VI Strengths: -Correlation between use of greater # of drugs and longer LOS reaffirmed in other studies. -Important determinants discussed in discussion group coincide with published literature in other studies. Weaknesses: -Lack of common, homogenous criterion to clearly define med errors. -Few published studies.

			Phase 2 *n*=2-4 experts. (Professionals with extensive health care experience) for discussion group. Phase 3 *n*=38 nurses Voluntary consent. 75% participated in CE Conducted in Gen Resuscitative unit and ICU.	-Identification of types of ME's. -Improved knowledge level reduced knowledge gaps. -Improved protective factors.		"omnipresence of the analysis" Percentages Averages Chi-square. Coding	GMEI-1.93% Phase 1: Prescription/transcription error rate-1.32%. (Most common error writing of Rx). Sig correlations between most variables indicating wide range of causes of ME's. More meds admin, longer LOS, increased prob of errors (p=0.001). Prescription/transcription relationship strong (p=0.003). (Mann-WhitneyU- p<0.05) Phase 2: 4 major areas identified by focus group: Critical care context, organization of ICU, personal factors, and med admin process. Phase 3: Level of drug knowledge: 81.67% female of which 75% had CE, 15% CE in Pharm 42.5% of RN's failed drug knowledge test.	-Partially limited by the intrinsic limitations that contain the error analysis methods used. -Small analysis sample comprised only of nurses. -Unvalidated ad hoc questionnaire used. Study done according to conditions of respect for individual fundamental rights and ethical postulates. Approved by Clinical Research Ethics Committee at General Hospital of Valencia prior to commencing. Authors declare no conflict of interests. No risk of harm if implemented. Feasible in practice. USPSTF grade-A Level of Certainty- Moderate

Sarfati, L., Ranchon, F., Vantard, N., Schwiertz, V., Larbre, V., Parat, S., Faudel, A., & Rioufol, C. (2019). Human-simulation-based learning to prevent medication error: A systematic review	No theory or hypothesis stated.	Systematic review Quantitative.	*n*=21 studies. Database of Medline/ PubMed searched from Jan 2000-June 2015. Search terms:Pt Sim, ME's, Sim healthcare. Focused on pharm, med or nursing students. 6 studies-learning by sim for pharmacy, MD's, and nursing students. 15 studies-training for healthcare prof (8 focused on preventing ME's, 4 focused on crisis management, 3 focused on communication).	IV--Application of ME prevention strategies-Human simulation-based training. DV--Reduced ME's in all categories of ME incidence. -Improved knowledge level. -Improved crisis management. -Improved communication skills.	Clinical scenarios assessing competencies in pharm, drug dose calculations, drug reconciliation, or detection of prescription error. OSCE's on 11 core tasks Likert scale Knowledge evaluation PRISMA-P	Chi-square Percentages Pooling Random Effects model Odds/ratio Statistical heterogeneity	Concluded that skilled simulation training can be safe and effective way to train nurses in common and rare events related to medication preparation and administration in healthcare environments It was not demonstrated that simulation training was more advantageous than didactic learning in reducing MAEs	Strength of Evidence (LOE)-I Strengths: -Simulation training does not directly involve patients. -All steps of process are targeted involving students in medicine, pharmacy, or nursing. -Rare case scenarios can assess skills during crisis or rare and risky situations. -Useful for assessing and practicing interdisciplinary communication skills. -Taking part in such programs can enhance participants involvement, satisfaction and adherence, reducing ME's. Weaknesses: -Only 4 RCT's designed to assess simulation training superiority over traditional learning in ME reduction. -Lack of subjective quantitative tools to measure efficacy. -Only 12 out of 21 studies assessed error rate. -Study periods short. -Small sample of simulated scenarios. -Limited to a few clinical cases and small cohorts due to difficulty in designing real life scenarios with sufficient participants. -Heightening of participants vigilance when aware of the program may bias results.

			Selected learning programs enrolled between 28-201 students 1-3 clinical scenarios tested and assessed for competencies					No risk of harm if implemented. Feasible in practice. USPSTF grade-A Level of Certainty- Moderate
Bessa Mieiro, D., Camargo de Oliveira, É. B., Pagotti da Fonseca, R. E., Mininel, V. A., Zem-Mascarenhas, S. H., & Machado, R. C. (2019). Strategies to minimize medication errors in emergency units: An integrative review.	What strategies are utilized by ED nursing teams to minimize ME's in ER's.	Quantitative, Systematic review	*n*=3 articles. Data collected from May 2017-June 2017. 337 articles found. 68 articles selected 3 articles analyzed. 2 studies by nurses 1 study by other prof.	IV- -Application of medication error prevention strategies through PD, instrumentalization, education, and elaborated protocols with participation of multidisciplinary teams. DV--Reduced incidence of ME's -Improved education through lectures and clinical simulation. -PD. -Instrumental zation of professionals	Validated instrument adapted to meet objective of research used to analyze the studies in pairs. PRISMA-P	Percentages Chi-square Pooling Statistical heterogeneity Odd/ratio Random effects model	One study showed 526 potential drug interactions in 159 Rx's. (79% of Rx's analyzed) Of those 109, (21%) were serious interactions. 354 (67%) moderate, 63 (12%) mild Strategies recommended for prevention of MAEs: continuing education, implementation of the PD method, elaboration of protocols, creation of multidisciplinary committee to reduce MAE's, and implantation of prescriptions by computerized system with	Strength of Evidence (LOE)-V Strengths: -Results add to knowledge about ME's and strategies to prevent them contributing to professional clinical practice by adding the multiprofessional team approach. -Educational, organizational strategies and new technologies identified that were effective in minimizing and preventing ME's Weaknesses: -Small sample size. -Study lacks work related to subject explored. -No studies of greater evidence. No risk of harm if implemented. Feasible to use in practice. USPSTF grade-A Level of Certainty-Moderate

			Databases searched: PubMed, BDenf, Cochrane, LILACS. No time limit, no language rest. Full text.	and elaboration of protocols. -Use of new technology.			unit dose and bar code in medication administration	
Johnson, M., Langdon, R., Levett-Jones, T., Weidemann, G., Manias, E., & Everett, B. (2019). A cluster randomised controlled feasibility study of nurse- initiated behavioral strategies to manage interruptions during medication administration	Hypothesized change after e-learning intervention: 1. Change will occur in nurse-initiated BMS. 2. Reduced # of interruptions. 3. Reduced rate of procedural and clinical errors.	Quantitative RCT Parallel cluster RCT	*n*=42 nurses in intervention group. 806 med prep and admin events observed (402 pre-intervention, 404 post-intervention) 15 wards self-nominated and agreed to participate. 8 med/surg wards within 4 hospitals in	IV- -Application of medication error prevention strategies: Behavioral strategies to manage interruptions during med admin DV--Reduced incidence of ME's. -Reduced interruptions during med prep and admin. -Improved overall procedures.	Structured non-participant observational approach tool developed for data collection (#interruptions, meds, procedure failures, and clinical errors). Inter-rater reliability assessed for observers with Kappas ranging from 0.06-1.0 for clinical errors, 0.64-1.0 for procedural fails, showing mod-high reliability	Clustering Percentages rates, frequencies Chi-square Pearson's R Linear regression ANOVA Coding behaviors	Behavioral strategies: Stop med admin to engage- Control group- 70.87% at baseline. 74.67% f/u Intervention group- 66.12% baseline 77.27%f/u Management strategies used and type of interruption at baseline, no sig difference (x^2=5.993, p=0.199).	Strength of Evidence (LOE)-II Strengths: -Ethics approval obtained from local health district and university HREC. -Baseline studies done to compare -Observers trained and reliability verified. -Observers remained 2 m away. Weaknesses: -Small group of general wards studied. -Diversity of patient caseload limited effects of intervention. -No assessment on whether RN's completed all education module. -Observations on errors may have been underestimated in both intervention and control wards.

			Sydney, Aus. And New Zealand (3 med wards 1 med/surg ward, 1 surg ward, 1 aged care unit, 1 hem/onc unit, 1 palliative care unit). Observers logged all interruptions during med admin by participating RN's over 1 month period prior to and following delivery of intervention (50 per control and intervention) 4 wards-Intervention 4wards-Control.		SAS Version 9.4 (linear mixed-effects modeling) and SPSS Version 25 used to conduct analysis.		No sig diff between baseline and f/u in type of strat used by control group ($x^{2=}$3.874, p=0.423). Intervention group had fewer multitasking 22.73% baseline, 15.91% F/U. No sig results differences found in # of interruptions (p=0.82), Procedural failures (p=0.19) Clinical errors per 100 meds (p=0.32), between intervention and control wards. Differences in behavioral strategies were found in intervention wards.	No risk of harm if implemented. No conflict of interest declared. Feasible in practice. USPSTF grade-B Level of Certainty- Moderate

			Study conducted between Aug 2015-May 2016.					
Ragau, S., Hitchcock, R., Craft, J., & Christensen, M. (2018). Using the HALT model in an exploratory quality improvement initiative to reduce medication errors.	No theory or hypothesis stated.	Quantitative, Literature and quality improvement initiative	Lit review done to find suitable framework to address human factors in ME's. CINAHL, Medline, PubMed searched from 2005-2018 for lit pertaining to ME's in nursing, in English. *n*=7 reviews QI initiative: *n*=1 medical ward of nurses. 32 bed acute med ward in reg district hospital in	IV—Application of error prevention strategies: HALT model DV--Reduced incidence or ME's -Increased Knowledge through education -Reorganization of nurse workload. -Increased self-awareness and team awareness for risk factors. -Increased colleague support.	PRIME data accessed and reviewed in relation to ME rates over 2 month period during HALT project against preceding 2 month period. Krippendorff's framework used to analyze responses from nurses to open ended questions. Pre-test/post-test PRISMA-P	Frequencies percentages Coding based on word freq. Pooling Statistical heterogeneity Odds/ratio Random effects mode	Post-implementation of HALT model total ME's reduced by 31.7% (n=71) Mistakes related to human factors reduced by 25.3% (n=23) Me's linked to communication/documentation errors reduced by 22.9% (n=20) The goal of this initiative was to reduce MAEs on the ward by 25% and was successful in reducing errors by 31.7% Study suggest that human factors relating to MAEs are often overlooked, but the use of methods such as HALT to alleviate risks of errors can play a significant role in reducing MAEs	Strength of Evidence (LOE)-V Strengths: -Study highlighted that individual nurse and nursing team play important role in recognizing human factors contributing to med errors. -Shows that simple strategies such as HALT can promote culture of support and empowerment. -Local data can be customized for easier pt. care solutions. -Exhibits that building a strong foundation for risk analysis and multi-level programs in which data can be generated to other clinical settings. Weaknesses: -Small study conducted in 1 med ward. Necessary sample size calculated to be 111 participants. -PRIME does not collate data Assoc with contributing factors such as med charting, high-acuity pt.'s, demands. No risk of harm if implemented. Feasible in practice. USPSTF grade-A Level of Certainty- Moderate

			Queensland, Australia. Ward uses Practice Partnership Model Data from hospital's PRIME reviewed for error rates over 2 month period. Rate of errors during HALT project compared to rates of errors in previous 2 months.					

Legend:

AID-Automated infusion devise

BCMA-Bar-coded med administration

BMS-Behavioral management strategies

BSN-Bachelor's degree in nursing

CE-Continuing education

CHR-Conventional handwritten records

CPOE- Computerized physician

Legend continued:

CWS-Changes in work schedule

DPMO-Defects per million opportunities

ED/ER- Emergency department/Emergency room

EHR-Electronic health record

EMR-Electronic medical record

F/u-follow up

Gen Resus- General resuscitative unit

GMEI-Global medication error index

GYN- Gynecology unit

Hem/Onc-Hematology/Oncology

HREC-Human Research and Ethics Committee

ICU-Intensive care unit

IPI-Interprofessional performance improvement team

IS-Intravenous system

LOS-Length of stay

MAE-Medication administration error

MD-Physician

ME- Medication error/Modules of education

Med-Medication

Legend continued:

MEMS-Medication error minimization scheme

MR-Medication reconciliation/involvement

NCC MERP-National Coordinating Council for Medication Error Reporting and Prevention

OSCE-Objective structural clinical examinations

PD-Positive Deviation

PDSA-Plan-Do-Study-Act

Pedi-Pediatric unit

PG-Protocols and guidelines

Pharm-Pharmacology

POV-Point of view

PRIME-Proactive Risk and Incident Management Excellence (Clinical incident information system)

PRISMA-P-Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols

Prof-Professional/profession

Pt-Patient

QI-Quality improvement

RN- Registered nurse

Rx-Prescription

Sig-Significant

Legend continued:

Sim-Simulation/simulated

SSCD- Support systems for clinical decision-making

Surg-Surgical unit

yr.-Year

ZUMS- Zahedan University of Medical Scienc

Appendix B

Instrument 1

The WCCAT adopts a five (5) phase process to undertaking an observation study, analyzing the data, feeding back to clinical teams and developing action plans. The five phases are:

1. Pre-observation
2. Observation
3. Consciousness Raising and Problematization
4. Reflection and Critique
5. Participatory Analysis and Action Planning

To view full WCCAT instrument with instructions please visit https://www.fons.org/resources/documents/Tools%20and%20resources/19-WCCAT.pdf

Appendix C

Instrument 2

An audit tool was developed specifically for the Air 1 program with eight recommended steps to follow for safe medication preparation and administration:

Step	Medication Process	Yes	No	N/A/Comments
1	Both caregivers confirm medication treatment is correct for patient condition according to protocol.			
2	Both caregivers check and confirm medication label for right medication and right dosage.			
3	Both caregivers independently calculate dilutions and concentrations of all additive solutions prepared.			
4	Same caregiver prepare and administer medication			
5	All solutions prepared must be accurately and adequately labeled			
6	Patient allergies should be confirmed if at all possible			
7	Intravenous infusion rates double checked by each caregiver			
8	Both caregivers sign medication portion of patient chart and confirm documented medications			